Joint Control and Generalized Nonidentity Matching: Saying When Something Is *Not*

Barry Lowenkron and Vicki Colvin
California State University, Los Angeles

This study investigated how the *absence* of a specified stimulus can control behavior. Four children were trained in nonidentity matching, and as a control, four were trained in identity matching. Both performances were produced by training overt mediating responses, so that in identity matching, the selection of a particular comparison was evoked by the repetition of a sample tact to the comparison, and in nonidentity, by the inability to repeat the sample tact to the comparison. Successful generalization of the performances indicated that they were indeed controlled by these general features rather than by stimulus-specific features. Comparison selection thus served as an autoclitic report about other verbal behavior. In particular, generalized nonidentity matching indicated that sensitivity to discrepancies between what a sample specifies, and what is actually presented, can be accounted for behaviorally, without recourse to hypothesized cognitive mediators.

In a relational matching task, one stimulus specifies the selection of another: the subject must select the specified stimulus, but may not select any other. Clearly, selecting a specified stimulus by pecking or pointing is a response, but what happens with the stimuli that are not specified? Can they also evoke a response?

The issue goes to a crucial class of intellectual performances: the recognition of events that do *not* possess a specified relation to each other. Recognizing that a number is missing from the series 1, 2, 3, 5, 6 in an example of this class, but the issue extends to more abstract performances such as saying that a red circle is not a member of the class of stimuli that may be described as *blue squares*, and that an automobile is not an item of furniture.

Although an explanation of behavior of this sort is vital to any complete account of intelligent behavior (Miller, Galanter, & Pribram, 1960; Neisser, 1967), it has been virtually ignored in behavior analysis. It is easy to see why. An S^D controls a response by its presence. There is no parallel concept that would account for control by its absence — only by its replacement with another stimulus as in stimulus generalization. The fact remains however, that we do respond to the absence of specified stimuli.

The generalized relational matching task provides a means of examining these issues experimentally. Generalized relational matching is demonstrated when subjects select novel comparison stimuli based on a consistent relation to the samples. To produce such a performance, subjects are first trained to select from among a small set of training stimuli on the basis of relations such as *same as, greater than, less than, further, nearer, before, after,* etc. Generalization based on the acquired relation, may then be demonstrated if subjects continue to select on the same basis when exposed to novel stimuli (Saunders & Sherman, 1986).

From a cognitive perspective, performances of these sorts are taken to indicate the operation of a mediating cognitive entity such as a rule (Gollin & Shadler, 1972) or a strategy (Campione & Brown,

This research was supported by Grant HD 23123 from the National Institute of Child Health and Human Development. We would like to thank Pam Kisor, Director of the Anna Bing Arnold Children Center for her help and cooperation in coordinating subject participation and in making facilities available. Reprints may be obtained from Barry Lowenkron, Dept. of Psychology, California State University, Los Angeles, Los Angeles, CA 90032

1974). But prior studies (Lowenkron, 1984, 1989) have suggested that a strictly behavioral account can be provided if it is phrased in terms of joint stimulus control over mediating verbal behavior.

Generalization in the delayed identity matching task provides a simple example of how joint control facilitates these seemingly abstract performances. Consider, for example, a task in which pictures of animals must be matched. For generalized identity matching to appear, during training the subject must learn to tact comparison stimuli, and these tacts (Skinner, 1957, ch. 5) must then come under joint control. This requires the subject to respond to each sample by providing a name (i.e., a tact) for it, and when the sample is removed, rehearse the tact as a self-echoic repetition (Skinner, 1957, p. 64) over any delay interval and into the comparison presentation. For example, the subject names a sample picture as a *dog*, then rehearses this name until the comparisons are presented. At this point only another picture that could be tacted as *dog* will allow the subject to continue to repeat the sample tact as *both* a self-echoic and also as an accurate tact of the picture. Any other comparison would require either an inaccurate tact (e.g., calling a picture of a cat *dog*) or else a cessation of the self-echoic (i.e., saying *cat* instead of *dog* to the picture of a cat).

The correct comparison thus provides a unique event: only it allows for the emission of a response (*dog*) which is both self-echoic with respect to prior rehearsal and (jointly) an accurate tact with respect to the current comparison. This unique event then serves to evoke a comparison-selection response such as pointing to the comparison[1].

While joint tact/self-echoic control may be unique to the correct comparison on each trial, it is common to all trials in which a correct comparison appears, and this provides the basis for generalized matching: Once a subject learns to select the comparison which participates in joint control, generalized matching should occur with any novel stimulus for which the subject has an available tact. The self-echoic component of joint control should take care of itself: presumably subjects can echo any sample tact they may make. In essence, joint control sustains generalization because it serves as a common antecedent for a common comparison-selection response.

There are however, certain aspects of joint control which remain unclear. In particular, the nature of control over behavior before the correct comparison is encountered. One possibility, paralleling the S^D account, would have it that prior to encountering the correct comparison, the subject is essentially passive: scanning the comparisons under the control of general features of the task (i.e., Michael, 1985), while rehearsing the sample tact. When the correct comparison is encountered, the occurrence of the self-echoic under joint control sets the occasion for a comparison-selection response, such as pointing, which virtually interrupts the scanning. Essentially, there is but one response to a comparison — selection — and it is evoked by the occurrence of joint control.

The other possibility is that correct and incorrect comparisons each evoke different responses. This could happen if, in addition to pointing to a comparison when it permitted joint control, the subject responded differentially, by moving to another comparison, when one was

[1]Joint control always contains a rehearsal component, but it is not limited to the tact/self-echoic combination. Thus a word in the dictionary is located by rehearsing the spelling (an intraverbal) while perusing the dictionary until an entry is located whose letters, as they are read from the page, evoke joint tact control with the rehearsed intraverbal. Likewise, locating a specified book title on a shelf would involve joint control between self-echoic rehearsal of the title sought and a textual response to the title itself.

The presence of these rehearsal components distinguishes joint control from the various forms of multiple causation described by Skinner, (1957). Under multiple causation different sources contribute algebraically to the strength of emission of a common verbal response. Under joint control the strength of the response is not the issue. It is assumed the response is emitted as an echoic or intraverbal. The presence or absence of joint control refers to situations in which an additional stimulus does (or does not) evoke the same response topography and thereby permits (or conflicts with) yet another rehearsal of the response. Generalized non-identity matching requires responding to these conflicts.

encountered which did not permit joint control. The subject thus moves from an incorrect comparison to another comparison, not as a result of some passive scanning strategy, but as a result of a direct test of the properties of that comparison relative to the properties of the comparison being sought.

The difference between these alternatives is small, but important. The first case treats the absence of the correct comparison as a non-event, and so adds nothing to the S^D account of behavior in the absence of a stimulus. The second case treats the absence of a specified stimulus as a detectably different form of stimulus control: one arising from the inability to tact a comparison under joint control and capable of controlling other responses.

Where the mediating behavior is vocal, none of these events can be measured directly, and so in previous studies of joint control (Lowenkron, 1984, 1988, 1989), mediating responses were made overt so as to be directly measurable. This overt-response technique allowed for a direct assessment of the role of joint control in generalized matching-to-sample.

The aim of the present research was to apply this overt-response technique to the question of responding in the absence of a specified comparison in order to learn if the nonoccurrence of joint control can itself control a comparison selection response. To do so, performances in generalized identity and nonidentity matching tasks were examined.

In these tasks, subjects selected a comparison whose axis of symmetry bore the appropriate relation to the sample. The procedure trained subjects to tact the sample's orientation with an overt response, and then, while maintaining the sample tact, attempt to tact the various comparison stimuli. In nonidentity matching, subjects had to reject comparisons which permitted joint control, and select the comparison whose orientation required some tact other than the sample tact: that is, the comparison that did not engender joint control.

There are, of course, other behavior patterns that generate nonidentity matching. Subjects might, for example, accurately tact a sample's orientation (e.g., *up*), and then randomly transform the tact to some other orientation (e.g., *left*). If they then seek to select a comparison that permits joint control with this orientation, the result will also be a nonidentity match. The overt response technique was intended to guard against this by providing for the direct measure of component responses.

METHOD

Subjects

Four girls (GS, KS, NN, and JM) and four boys (DN, KC, KJ, and DR) from the university day-care center served as subjects. All were between 4.5 and 5.4 years old with a mean age of 5.0 years.

Apparatus and Setting

Stimuli. As illustrated in Figure 1 (panel A), two sets of symmetrical shapes were used. The shapes ranged from 1.3 to 3.3 cm in both height and width.

During the early stages of training, each shape was presented as a single black figure on a white 3 by 5-in card. During later stages, they were presented on a 19-in (45-cm) Amdek II® color monitor controlled by a Commodore 128D® computer. When presented as samples, the stimuli were located at the center of the screen. When presented as comparisons, the stimuli were presented with one in each of three corners of the screen (Figure 1, panel D). Over trials, comparisons were counterbalanced across the four corners of the screen.

In addition, subjects used a 7.7-cm arrow to indicate the orientation of shapes (Figure 1, panel B).

Training media. To train subjects in the use of the arrow, four series of cards (the arrow-fading series) were prepared: one series for each stimulus of the training set. Figure 1, panel C illustrates the members of a series for one of the training-set shapes. In each series, arrows at the base of each shape diminished in completeness over the six cards in each series.

Baseline and generalization test sequences. All training-set baselines and generaliza-

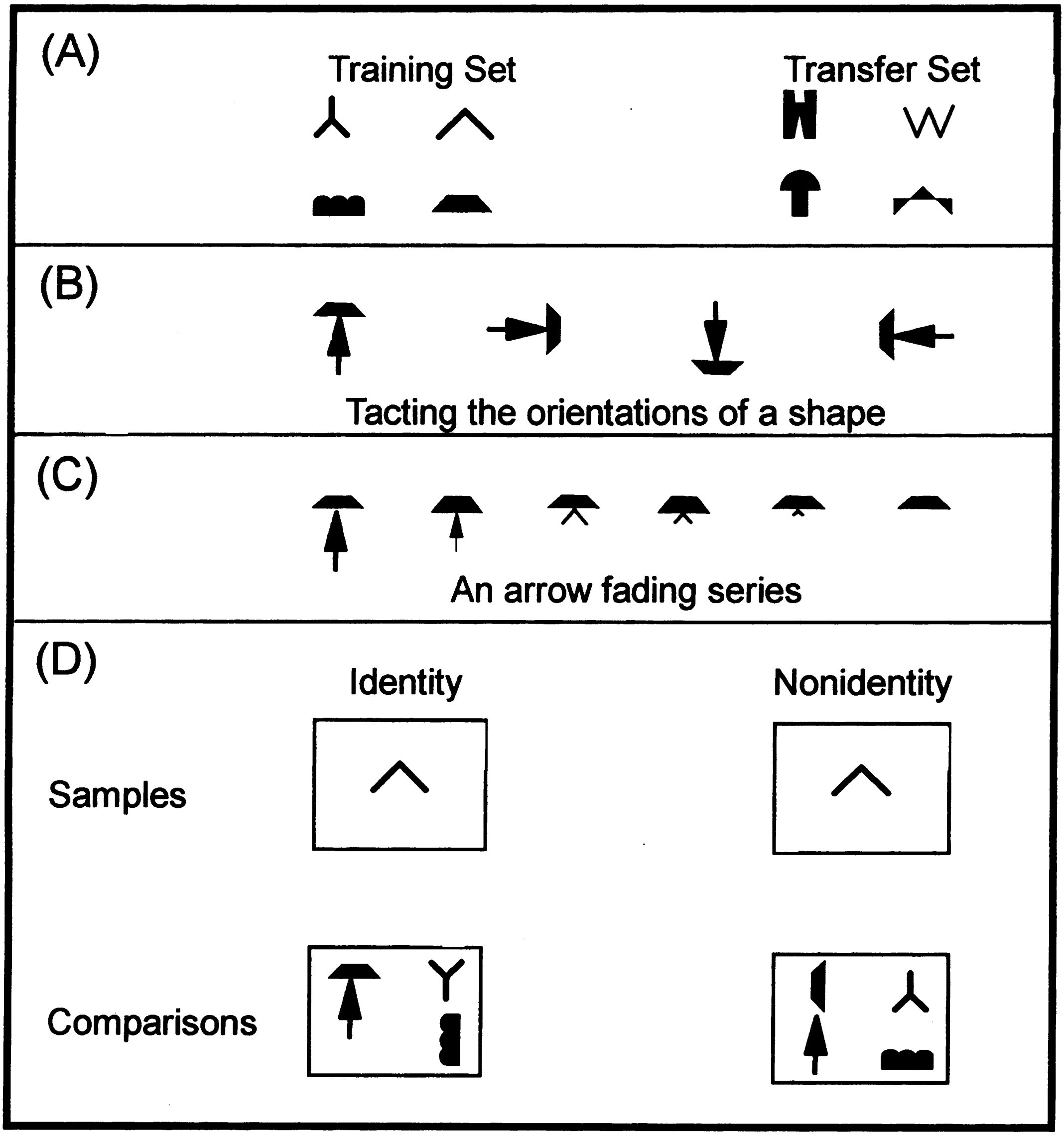

Fig. 1. Stimulus sets and training procedures. (A) Stimulus sets used for training and generalization tests. All shapes are shown in an orientation tacted by pointing the arrow straight up. (B) Illustration of the procedure used to teach subjects to tact the four orientations of a shape. (C) Procedure for fading control of tacting to a shape's orientation. (D) Examples of identity and nonidentity matching trials. In the identity match task, the upward arrow correctly tacts the orientation of the trapezoid and thereby indicates that this is the correct comparison. In the nonidentity matching task, the arrow does not tact the orientation of the trapezoid, and thereby indicates that this is the correct comparison.

tion tests consisted of sequences of 12 counterbalanced zero-delay matching trials presented on the computer monitor. Training-set baselines contained only the training-set stimuli. Each shape appeared at least once as a sample. Generalization tests contained eight trials with the transfer set stimuli, interspersed with four trials with the training set stimuli.

As described below, not all trials had consequences for correct or incorrect selections, but during all consequated trials, an inaccurate match produced a 3-s blackout of the monitor screen followed by the next trial. The first accurate match on a consequated trial produced the Sesame Street® character Big Bird® at the correct comparison along with a 2-s tone. The screen then cleared, and a string of 12 cookies appeared from left to right across the screen with a little boy to the right of the rightmost cookie. Touching the boy caused him to move left and pick up one cookie. Subsequently, on trials with consequences, correct matches produced the string of remaining cookies, and the subject had the opportunity to pick up more cookies.

When all of the cookies had been picked up, the screen again cleared, and a final reinforcement routine began. While the computer played a 20-s tune, animated characters moved across the screen. The child was then allowed to select a sticker.

Because 12 correct responses were required to pick up all the cookies, the actual number of trials in a test depended on the number of errors; the 12-trial stimulus sequence was repeated until all 12 cookies had been picked up. During tests, the stimulus sequence was repeated as needed in order to acquire at least 24 trials of data. Regardless of the number of trials, subjects were always allowed to finish collecting the cookies so they could receive a sticker.

Data collection. The selection of comparisons on each trial was measured by a touch-sensitive screen (Personal Touch Corp. IBM analog model) which detected the locations subjects touched. This information, along with a complete record of the stimuli presented on the trial, was automatically recorded by the computer. An observer made a written record of subject's comments.

Setting. Sessions were conducted in a small, quiet room at the university daycare center. The child sat at a small table facing the monitor. The computer and keyboard were to the right of the subject, in front of the experimenter. Between the child and experimenter lay the sheets of stickers. The observer sat behind the child.

Procedure

Sessions, averaging 30 minutes, were conducted two or three times per week. In each session, previously taught behavior was reviewed and, where necessary, retrained before new training was begun.

General overview. Two boys and two girls were assigned to the identity condition and the same to the non-identity condition. Each component of the initial zero-delay matching performance was trained separately. The components were then integrated to produce a performance in which children tacted the orientation of the sample by appropriately orienting the arrow, and, while retaining the arrow's orientation, selected a comparison appropriate to the arrow's orientation and to the matching condition. The performance was then tested for generalization to the transfer set.

Sample-coding training. In this phase, children learned to tact the orientation of a sample shape by placing the arrow card along the shape's axis of symmetry. These tacts were taught separately for each of the four training-set shapes. Initially, the first card of the arrow-fading series for the trapezoid was placed alone on the table (Figure 1, panel c). The subjects were taught by demonstration and prompting ("Where does it go?") to orient and place the arrow on top of the card as the latter was turned randomly to orientations of 0, 90, 180, and 270 degrees. After four consecutive correct placements of the arrow, the procedure was repeated with the V- shape. After four consecutive correct placements with the V- shape, the second card of the arrow-fading series for each shape was introduced, and the procedure was repeated. Across subsequent steps of the arrow-fading series, the procedure was continued until the children correctly tacted the orientations of the two shapes four consecutive times using the final step in the series. Each correct placement of the arrow was followed by verbal praise with an opportunity to select a sticker after approximately eight correct trials (variable-ratio 8 or VR8).

The entire procedure was then repeated with the remaining two shapes of the training set. After the second pair was trained, all four shapes were presented in a final review, with a criterion of two consecutive correct tacts of each shape in each orientation.

In the next stage of training, the shapes were presented in all orientations on the computer monitor as samples with a white background color. As each shape was displayed, subjects were prompted ("Where does it go?") to place the arrow in the appropriate orientation and press it to the figure on the monitor. The experimenter gave verbal praise for an accurate arrow orientation and the screen border changed to a novel color for 0.5-s. Again, stickers were provided on a VR8 schedule.

Training Comparison-selection. In this phase, children learned to use the arrow's orientation to select a comparison. In the identity condition, they learned to select the comparison whose orientation coincided with the arrow's, as it had been trained in the prior sample-coding response training phase. In the non-identity condition, the children learned to select the comparison whose orientation did *not* coincide with the arrow's (Figure 1, panel d). Both conditions were trained with a white background.

To train this, the experimenter rotated the arrow to one of the four orientations and handed it to the child. If the child changed the arrow's orientation, the experimenter returned it to its original state and admonished the child not to change it. A correct comparison then appeared. In the identity condition the orientation of the comparison coincided with the arrow's orientation. In the nonidentity condition it did not. The experimenter then prompted the subject to put the arrow on the shape and press the screen. This produced a novel screen color and a brief reinforcement sound. A sticker was provided on a VR8 schedule.

After 12 consecutive correct trials, three with each shape, a second and incorrect comparison was added to the screen: In identity matching this comparison was in an orientation that did not coincide with the arrow's, while in the non-identity condition, the orientation was the same as the arrow's. Thus, the task now required the subject to actually use the arrow's orientation to find the correct comparison. Subjects in the identity condition were asked "Where does the arrow go?" (the identity prompt) to prompt a selection of the shape whose orientation coincided with the arrow. Subjects in the non-identity condition were asked "Where is the music?" (the nonidentity prompt) to prompt a selection of the shape whose orientation did not coincide with the arrow.

On the first six trials, the experimenter used physical guidance: intercepting errors by touching the subjects hand and saying "no" before the screen was pressed thereby forcing a correct selection. Correct selections were reinforced as described above. Incorrect selections produced a 2-s screen blackout followed by the next trial.

After 12 consecutive correct trials, a second incorrect comparison was added. (Figure 1, panel D) Over subsequent trials, the prompts were faded to a 5-s delay and then omitted. Correct and incorrect selections were consequated as described above.

Final training. This procedure integrated the complete performance. Trials began with the presentation of a sample. The subject tacted the sample's orientation with the arrow and then pressed the arrow to the screen, with its orientation unchanged, to produce the comparisons. Next, the subject placed the arrow at the correct comparison and pressed the screen to select the comparison. On the first few trials, the identity and nonidentity prompts were reinstated. Training continued until the subject correctly matched in 11 out of 12 consecutive trials with no prompts.

Baseline performance. In the next session, the 12-trial training-set sequence was presented several times. The first time, all responses were reinforced. On subsequent exposures, consequation was eliminated on half of the trials interspersed irregularly throughout the sequence. However, subjects could pick up cookies earned for correct responses on these trials during the remaining consequated trials. Reinforcement was attenuated here to insure that responding would not be disrupted later, during the non-reinforced generalization trials. This procedure was repeated until the subject completed two consecutive sequences with no more than two errors.

Transfer-set sample coding. Subjects were next trained to use the arrow to tact the orientations of the stimuli of the transfer set by applying the sample-coding training procedure previously used with the training set. Training was continued over at least two sessions.

Generalization test. At the start of the session, the training-set baseline, with reinforcement attenuated, was presented until the subject completed 11 out of 12 correct trials. If this did not occur in the first two runs, the baseline was given twice more to provide a total of 48 practice trials, and the session was ended. If the subject made 11 correct selections in 12 trials, then two generalization test sequences were presented to provide a minimum of 24 test trials. These each consisted of 8 nonreinforced trials with transfer set stimuli interspersed with 4 reinforced training set trials.

Test for oddity matching. In the nonidentity procedure, in order to have three comparisons, the two incorrect comparisons were always in the same orientation — with the correct comparison in a different orientation. It was therefore possible to select the correct comparison by selecting the one in an orientation different from the other two (simultaneous oddity matching). To evaluate this possibility, some subjects were given the generalization test again, but with only two comparisons: one correct, and one incorrect. If subjects were indeed using the oddity solution, their performance on this test should approximate random selection (50% correct).

RESULTS

Figure 2 illustrates overall matching accuracy, as well as accuracy on each of the three components that comprised performance in the generalization test. The three components were measured as follows. A *sample tact* was scored as correct if the subject oriented the arrow, with respect to the orientation of the sample, as trained during sample-coding training. A tact was scored as *retained* if the subject retained and did not modify the sample tact (by changing the orientation of the arrow) before selecting a comparison.

A *comparison selection* was scored as correct if the subject selected a comparison appropriate to the matching relation they were assigned, and to the orientation of the arrow at the moment of selection. Thus, in identity matching, selecting a comparison whose orientation was specified by the current orientation of the arrow was scored as correct, while in nonidentity matching, selecting the comparison whose orientation differed from the arrow's current orientation was scored as correct.

Finally, a trial was scored as an overall *correct match* if the comparison selected bore the currently correct (identity or nonidentity) relation to the sample. This latter measure is partially redundant on the other three: While a correct performance of the three components necessarily produced a correct match, it was also possible for the subject to make two or more errors that canceled each other to produce an overall correct match. Thus, after tacting the sample's orientation, the subject could change the orientation of the arrow, and then select a comparison not specified by the current orientation of the arrow: the retention error and comparison-selection error thereby canceling to produce a correct match.

As the data indicate, all subjects showed high levels of generalized matching with the stimuli of the transfer set. Significantly, performance in nonidentity matching was comparable to identity matching. The uniformly high levels of retention of the sample tacts, combined with accurate comparison selection, indicate that subjects maintained all performances as trained. This fact, as well as the correlation of matching errors with errors in these performances, indicates that matching accuracy did indeed depend on accurate mediating responses.

The consistently accurate retention performance in nonidentity matching indicates that subjects did not locate nonidentical comparisons by changing the orientation of the arrow after tacting the sample and then selecting a comparison that allowed joint control with the modified orientation. Instead, it is clear, that subjects did indeed select the comparison that did not enter into joint control with

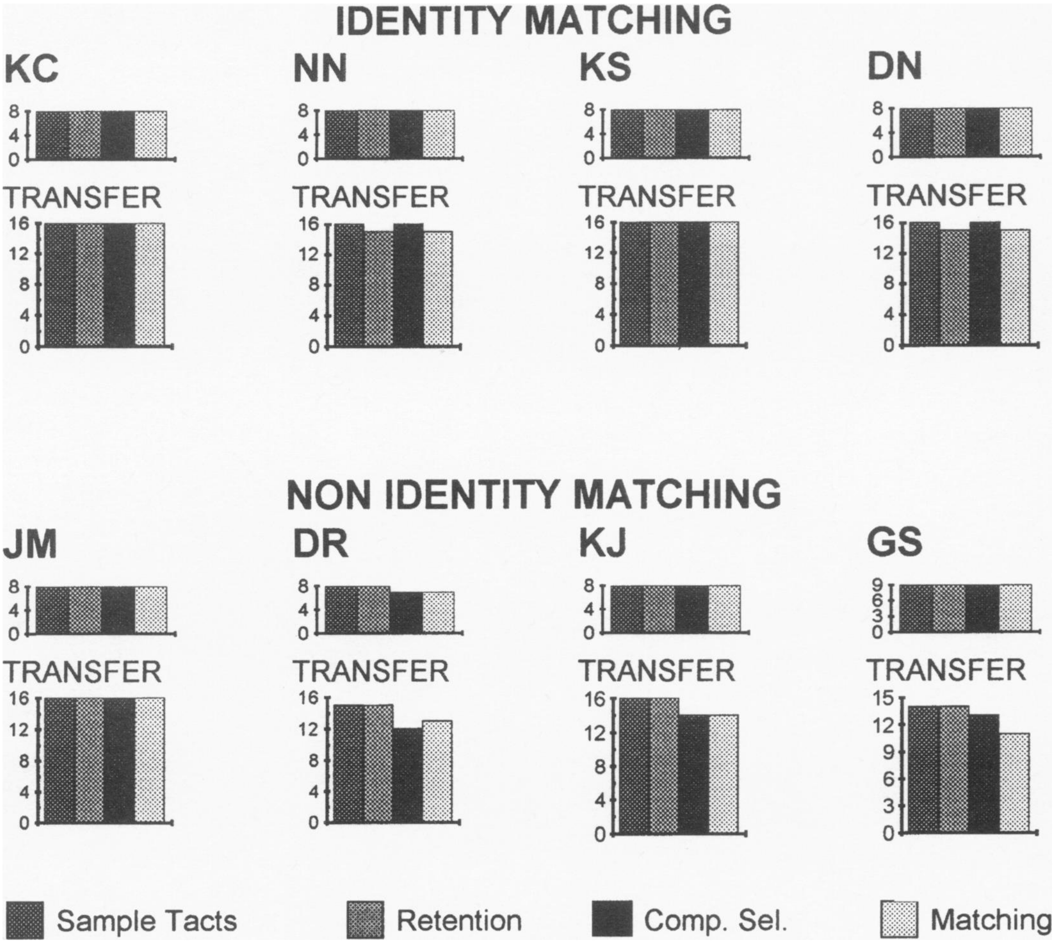

Fig. 2. Generalization test. Performance on three components (sample tacting, retention of the sample tact, and comparison selection) and overall matching accuracy in the identity and nonidentity matching tasks. For each subject performance on 8 trials with the training set stimuli are shown above the data for the 16 transfer set trials.

the sample tact. That is to say, subjects selected on the basis of not something, rather than different from something.

Finally, performance in the test for oddity matching with two comparisons was almost errorless. This indicates that generalized matching with three comparisons was not based on an oddity relation between comparisons, but again, on the relation of the correct comparison to the sample.

DISCUSSION

When presented with novel stimuli, subjects continued to select comparisons bearing the relations initially trained. This generalization indicates that comparison selection was not under the control of features specific to the training stimuli, but rather, was controlled by features common to all trials.

The fact that subjects could learn a specific response to the general class of stimuli that do not permit joint control, has several important implications. First, it suggests a certain symmetry between the generalized identity and nonidentity matching performances. If subjects can indeed learn specific responses to comparisons that do not permit joint control, then in identity matching, rather than depending on the general scanning strategy mentioned earlier, subjects may learn a specific response to the nonidentity comparisons, namely, to move to the next comparison. Thus, in identity matching, subjects select the comparison that permits joint control and move to the next comparison when they encounter one that does not, while in nonidentity matching, they select the comparison that does not permit joint control and move to another comparison when they encounter one that does. Matching performed in this way looks more like an active, goal-oriented behavior in which a goal is specified and sought out while comparisons that do not qualify are actively rejected.

There is however, a more general implication to the finding that generalized nonidentity matching may be based on the absence of joint control: It provides an account of how subjects are able to respond to absent events in general. Thus, the *D* is recognized as missing from the sequence *A-B-C-E* because this letter, when evoked as part of an intraverbal repetition of the alphabet, cannot be jointly emitted as a tact in the printed series. The letter is selected as a result of the stimulus pattern produced when the *D* is not emitted under joint control.

In effect, these responses tact the presence or absence of joint control over other verbal behavior. They thus qualify as the special kind of tact Skinner, (1957, p. 313-314) called a descriptive autoclitic (Lowenkron, 1991).

Descriptive autoclitics are tacts that describe events controlling other verbal behavior. These private events may be the controlling relations over a response, or the private products of a speaker's own behavior. Thus, in identity matching, by selecting a comparison, the subject indicates which comparison allows for a repetition of the sample tact under joint control, and in nonidentity matching, by selecting, the subject indicates which comparison did *not* allow for joint control.

Descriptive autoclitics may, of course, take on forms other than comparison selection. A subject may talk about a relation. On this account saying that a red circle can not be described by the phrase *blue square* autoclitically tacts the relation between the stimuli. The negative autoclitic *not* is evoked by the absence of joint control between the phrase *blue square* and a tact of the red circle. Similarly, a picture of a car would not be selected as an instance of the class *furniture* because a car does not evoke a tact that could enter into joint control with a self-echoic repetition of the sample category *furniture*.

The analysis does not only apply to the identity and nonidentity relations. As illustrated in prior research (Lowenkron, 1984, 1989), many other generalized matching relation can be trained. In these cases comparison selection was first brought under joint control, then a behavior was inserted which transformed the sample tact in some consistent fashion so that the comparison actually sought was one which entered into joint control with a consistent modification of the sample (i.e., *bigger*, *smaller*, *before*, *after*, etc.). Since the comparison selection response was still under joint control, it was still an autoclitic.

In these cases a second autoclitic is possible. An autoclitic controlled by the preceding transformation would allow a subject, after selecting a comparison, to report on its relation to the sample. Thus, saying of a selected comparison, *this is larger* is controlled by the preceding transformation of the sample tact.

Finally, this second autoclitic invites a behavioral account of performances cognitive psychologists currently ascribe to metacognition i.e., to cognition about ones own cognitive processes (Nelson, 1992). Thus, when a subject says of a selected comparison *this matches* or *this does not match* with reference to a particular sample, he or she is not describing the stimuli themselves; indeed, they may no longer both be present. Rather, according to the cognitive psychologist, the subject is reporting on his own state of knowledge about the stimuli. But from a behavioral viewpoint, these reports are autoclitics. The subject is tacting the nature of control (joint control or non-joint control) over some feature of his own behavior with respect to the stimuli.

In summary, it seems clear that matching performances trained under joint control have many, if not all of the characteristics commonly associated with intelligent performances. Not only does joint control provide the basis for generalized matching based on a variety of relations, as the present data and other studies (Lowenkron, 1984, 1988, 1989) illustrate, but logical analysis suggests that it also contributes to stimulus control over a variety of autoclitic responses. These post-selection responses describe both what was selected and also why, and so they seem to provide a fairly complete account of all the kinds of behavior usually seen in tasks of this type.

REFERENCES

Campione, J.C., & Brown, A. (1974). The effects of contextual changes and degree of component mastery on transfer of training. *Advances In Child Development and Behavior, 9,* H.W. Reese, (Ed.), New York: Academic Press.

Gollin, E. S., & Shadler, M. (1972). Relational learning and transfer by young children. *The Journal of Experimental Child Psychology, 14,* 219-232.

Lowenkron, B. (1984). Coding responses and the generalization of matching-to-sample in children. *Journal of the Experimental Analysis of Behavior, 42,* 1-18.

Lowenkron, B. (1988). Generalization of delayed identity matching in retarded children. *Journal of the Experimental Analysis of Behavior, 50,* 163-172.

Lowenkron, B. (1989). Instructional control of generalized relational matching to sample in children. *Journal of the Experimental Analysis of Behavior, 52,* 293-309.

Lowenkron, B. (1991). Joint control and the generalization of selection-based verbal behavior. *The Analysis of Verbal Behavior, 9,* 121-126.

Michael, J. (1985). Two kinds of verbal behavior plus a possible third. *The Analysis of Verbal Behavior, 3,* 2-5.

Miller, G., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior.* New York: Henry Holt & Co.

Nelson, T. O. (1992). *Metacognition: Core readings.* Boston: Allyn and Bacon.

Niesser, U. (1967). *Cognitive psychology.* New York: Appleton-Century-Crofts.

Saunders, R. R., & Sherman, J. A. (1986). Analysis of the "discrimination failure hypothesis" in generalized matching and mismatching behavior. *Analysis and Intervention in Developmental Disabilities, 6,* 89-107.

Skinner, B. F. (1957). *Verbal behavior.* New York: Appleton-Century-Crofts.